IN SITU CHEMICAL STUDY OF AN ANTARCTIC ENDOLITHIC COMMUNITY

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We have used a novel approach to characterize the inventory of chemical elements and some biologically important molecular ions from individual layers of an endolithic microbial community from the Beacon Sandstone, McMurdo Dry Valleys. By looking carefully at the chemical environment of the communities *in situ*, we can learn something about the interaction of the organisms with their environment, that is their rock habitat, as well as their interactions with each other. Quartz grains were examined from each layer of the cryptoendolithic community and also from the rock beneath the visually obvious layers of the microbial community and studied with three different microscopy/spectroscopy tools. First, using an environmental scanning electron microscope (ESEM) equipped with an energy dispersive x-ray fluorescence detector, we have imaged the grains as well as inventoried chemical elements associated with the biota and with the minerals. The grains were then studied with a Focused Ion Beam - Secondary Ion Mass Spectrometer (FIB-SIMS) that has a spatial resolution of 20 nm and a spectral resolution of 0.4 AMU. This instrument also allows one to collect electron images, as with SEM, and secondary ion images in addition to mapping elements and low molecular weight molecules, and the technique has successfully been applied to the study of industrial materials (Dunn and Hull, 1999; Phaneuf, 1999). Finally, a high mass resolution (0.0001 AMU) study was conducted on the same samples at a spatial resolution of 100 nm using a liquid metal ion source to ionize the samples for analysis with a Time of Flight (ToF) SIMS. In this study, chemical elements and both positive and negative molecular fragments ranging in size from hydrogen at 1 AMU to molecular ions at 1850 AMU were inventoried. Depth profiles were taken on Na, K, C, N, Ca, P, F, Cl, Br, Fe and Si as well as NO_3, CO_3, SO_3, SO_4, NH_2, $C_2O_4H_4$ fragments on the quartz grains using Ga ions to sputter an area of 160 x 160 μm into the mineral surface a few nm at a time.

The application of these high-resolution surface chemistry techniques to the study of a cryptoendolithic community is a novel one requiring little sample preparation other than cutting the sample into a small enough size to fit into the ionizing chamber. The relatively non-destructive nature of these analyses allows one to further probe the samples with portable imaging and spectroscopic instruments, including reflectance, fluorescence and vibrational spectra, all of which can be done in the field.

Dunn, D.N. and Hull, R. 1999. Applied Pysics Letters 75: 3414-3416.
Phaneuf, M.W. 1999. Micron 30:277-288.